

“REDUCTION OF GHG EMISSIONS IN PROPYLENE OXIDE PRODUCTION AT MTP HPPO MANUFACTURING CO., LTD.”



By

Document Prepared By: KBS Certification Services Pvt. Ltd.

Project Title	Reduction of GHG Emissions in Propylene Oxide Production at MTP HPPO Manufacturing Co., Ltd.
Version	02
Report ID	VCS.18.VER.013.MP02

Report Title	Reduction of GHG Emissions in Propylene Oxide Production at MTP HPPO Manufacturing Co., Ltd.
Client	MTP HPPO Manufacturing Co.,Ltd. South Pole Carbon (Thailand) Co., Ltd.
Pages	43
Date of Issue	16-February-2019
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Summary:

KBS Certification Services Pvt. Ltd. has been contracted by, “South Pole Carbon (Thailand) Company Limited” to undertake independent 2nd periodic verification and certification for the greenhouse gas (GHG) emission reductions reported from ‘Reduction of GHG Emissions in Propylene Oxide Production at MTP HPPO Manufacturing Co., Ltd.’ for the monitoring period 01/04/2014 to 31/12/2017 in the initial monitoring report version 01 date 12/11/2018, with regard to the relevant requirements of VCS Standard Version 3.7.

The project was validated and registered with reference no. 1502 under VCS (Verified Carbon Standard) program on 13/11/2014. The project was validated by RINA SERVICES S.P.A (validation report N° 2013-IQ-29-MD issued on 13-November-2014). This is the 2nd periodic verification of this project which covers the period from 01/04/2014 to 31/12/2017 (including both the days). The project is verified against the VCS Version 3. The verification is based on the monitoring plan of registered VCS Project Description document (VCS PD)/20/, requirements of VCS (VCS Standard and VCS Program Guide of VCS Version 3) and CDM Validation and Verification Standard for project activity version 02 /19/.

The project involves installation of Hydrogen Peroxide-based Propylene Oxide (HPPO) technology for the manufacture of Propylene Oxide (PO) at the production facility of MTP HPPO Manufacturing Co., Ltd, a joint venture between The Siam Cement Public Co., Ltd and The Dow Chemical Company. The project activity uses Hydrogen Peroxide-based Propylene Oxide (HPPO) technology instead of the conventional Chlorohydrin process. The conventional Chlorohydrin process is one of the typical processes in the Propylene Oxide industry that involves hydrochlorination process. In the Chlorohydrin process, Propylene (C₃H₆) is combined to hypochlorous acid to form a Chlorohydrin intermediate which is subsequently dechlorohydrinated to PO and leads to the formation of salts. While in the HPPO process, Propylene and Hydrogen peroxide is combined to produce PO. The project activity reduces GHG emissions by usage of lesser GHG intensive reagents and reduced process energy requirements in the HPPO technology.

The methodology applied for the project to estimate the GHG emission reduction is Approved VCS Methodology VM0023, “Reduction of GHG Emissions in Propylene Oxide Production”, version 1.0 /23/.

The verification is based on the VCS PD, proof of title, proof of right, additional documents related to baseline and monitoring methodology; the subsequent background investigation, follow-up interviews and supporting documents made available to the verification team by project proponent. A site visit was conducted to verify the data submitted in the monitoring report.

Monitoring report (MR)/02/, Emission reduction calculation spread sheet (ER sheet)/04/, Project Description document (VCS PD)/20/ and other supporting documents have also been made available to the verification team.

A risk based approach has been followed to perform the verification of the project activity. In the course of verification, 03 Corrective Action Requests (CAR) and 01 Clarification Request (CL) have been raised. All the CARs and CLs have been closed out successfully.

It is our responsibility to express an independent GHG verification opinion on the GHG emissions and on the calculation of GHG emission reductions from the project for the period 01/04/2014 to 31/12/2017 based on the reported emission reductions in the final monitoring report Version 03 dated 31/01/2019 for the same period.

Based on an understanding of the risks associated with reporting GHG emissions data and the controls in place to mitigate these, KBS planned and performed our work to obtain the information and explanations that we considered necessary to provide sufficient evidence for us to give reasonable assurance that this reported amount of GHG emission reductions for the period is fairly stated.

As a result of the verification, the verifiers confirm that the GHG emission reduction in the verification period from 01/04/2014 to 31/12/2017, including both the days, is **720,991 tCO₂e**.

KBS confirms the following;

Reporting period: 01/04/2014 to 31/12/2017

Year	Net GHG emission reductions or removals (tCO ₂ e)
2014 (01/04/2014 to 31/12/2014)	97,139
2015 (01/01/2015 to 31/12/2015)	211,930
2016 (01/01/2016 to 31/12/2016)	199,889
2017 (01/01/2017 to 31/12/2017)	212,033
Total	720,991

Table of Contents

1	Introduction	6
1.1	Objective	6
1.2	Scope and Criteria	6
1.3	Level of Assurance.....	7
1.4	Summary Description of the Project	7
2	Verification Process	8
2.1	Method and Criteria.....	8
2.2	Document Review	8
2.3	Interviews	8
2.4	Site Inspections	9
2.5	Resolution of Findings.....	9
2.5.1	Forward Action Requests	11
2.6	Eligibility for Validation Activities	11
3	Validation Findings.....	11
3.1	Participation under Other GHG Programs	11
3.2	Methodology Deviations	11
3.3	Project Description Deviations	11
3.4	Grouped Project	12
4	Verification Findings.....	12
4.1	Project Implementation Status	12
4.2	Accuracy of GHG Emission Reduction and Removal Calculations	29
4.3	Quality of Evidence to Determine GHG Emission Reductions and Removals	31
4.4	Non-Permanence Risk Analysis.....	31

5	safeguards	31
5.1	No Net Harm	31
5.2	Local Stakeholder Consultation	32
6	Verification conclusion	32
APPENDIX X: <title of appendix>		34

1 INTRODUCTION

1.1 Objective

KBS has been commissioned by 'South Pole Carbon (Thailand) Company Limited' to perform verification of its registered VCS project 'Reduction of GHG Emissions in Propylene Oxide Production at MTP HPPO Manufacturing Co., Ltd.', for the reported GHG emission reductions for the given monitoring period 01/04/2014 to 31/12/2017 (both dates included). The VCS projects must undergo an independent third party verification and certification of emission reductions as the basis for issuance of Verified Emission Reductions (VERs).

The objectives of this verification exercise are, by review of objective evidence, to establish that:

- The project activity has been implemented and operated as per the project description (PD) and that all physical features (technology, project equipment, and monitoring and metering equipment) of the project are in place;
- Monitoring report and other supporting documents are complete;
- The data is recorded and stored as per the monitoring methodology and approved monitoring plan.
- To confirm that the monitoring system is implemented and fully functional to generate Verified Emission Reductions (VERs/VCUs) without any double counting, and
- To establish that the data reported are accurate, complete, consistent, transparent and free of material error or omission by checking the monitoring records and the emissions reduction calculation.

1.2 Scope and Criteria

The verification scope is defined as an independent and objective review of monitoring report, VCS project description (VCS PD), including the monitored data and other relevant documents made available to verifier and information collected through performing interviews during on-site assessment of the project activity.

The project is assessed against the requirements of VCS standard version 3.7 and related rules and guidance. KBS has, based on the recommendations in the latest version of Verified Carbon standard, and employed a rule-based approach (as criteria) in the verification, focusing on the identification of significant reporting rules and the reliability of project monitoring.

The aspects to be covered under the purview of verification are:

- Ensure that the project activity has been implemented and operated as per the registered VCS PD and that all physical features (technology, project equipment, and monitoring and metering equipment) of the project are in place as per the documents provided by the client and on-site visit;
- Ensure that the monitoring report and other supporting documents provided are complete
- Ensure that the practiced monitoring system and procedures comply with the monitoring systems and procedures described in the monitoring plan and the approved VCS methodology;
- Evaluate the data recorded and stored are as per the monitoring methodology.

1.3 Level of Assurance

☒ Reasonable level of assurance

1.4 Summary Description of the Project

The project involves installation of Hydrogen Peroxide-based Propylene Oxide (HPPO) technology for the manufacture of Propylene Oxide (PO) at the production facility of MTP HPPO Manufacturing Co., Ltd, a joint venture between The Siam Cement Public Co., Ltd and The Dow Chemical Company. The project activity uses Hydrogen Peroxide-based Propylene Oxide (HPPO) technology instead of the conventional Chlorohydrin process. The conventional Chlorohydrin process is one of the typical processes in the Propylene Oxide industry that involves hydrochlorination process. In the Chlorohydrin process, Propylene (C_3H_6) is combined to hypochlorous acid to form a Chlorohydrin intermediate which is subsequently dechlorohydrinated to PO and leads to the formation of salts. While in the HPPO process, Propylene and Hydrogen peroxide is combined to produce PO. The project activity reduces GHG emissions by usage of lesser GHG intensive reagents and reduced process energy requirements in the HPPO technology.

As compared to the conventional processes based on Chlorohydrin technology, the HPPO technology reduces overall energy consumption, thus resulting in significant emission reductions. Verification team has checked the project activity equipments installed as the project site and found in compliance with the registered VCS PD /20/.

The project site is located in 10 Moo 2, Asia Industrial Estate, Banchang, Rayong, Thailand as verified during site visit.

Project initial crediting period is from 04-October-2011 up to 03-October-2021, Hence the monitoring period selected for 2nd periodic verification i.e. 01/04/2014 to 31/12/2017 is within the crediting period.

The total emission reduction for 2nd verification period from 01/04/2014 to 31/12/2017 is 720,991 tCO₂e. The emission reduction is calculated conservatively as per the applied methodologies.

Project entity information is presented below:

Item	Data
Project Entities	MTP HPPO Manufacturing Co.,Ltd
	15th Floor, White Group Building II, 75 Soi Rubia, Sukumvit 42 Road, Prakanong, Klongtoey, Bangkok, Thailand.
	South Pole Carbon (Thailand) Co., Ltd.
	2/22 Iyara Building, 6 th Floor, Chan Road, Thungwatdon Sathorn, Bangkok 10120, Thailand

2 VERIFICATION PROCESS

2.1 Method and Criteria

The verification process was carried out inline with the requirements VCS Version 3. In addition, the verification team followed the guidelines of the CDM Validation and Verification Standard. Standard auditing techniques and KBS's CDM Procedures were also applied during the verification. A risk-based approach was followed to carry out verification and access all the factors and concerns that relate to the issuance of emission reductions from a project activity.

They include:

- Identification of all the sources contributing to the baseline emissions, project emissions and emission reductions.
- Authenticity of the provided data is checked.
- A risk based analysis is carried out to ensure a clear and transparent assessment. The risks involved in this process are mainly with the informational flows and data recording.

KBS follows a risk based verification approach, wherein a desk review of the project documentation is undertaken, which is followed by an onsite visit by the members of verification team. The verification protocol is filled by the verification team that is based on standard auditing practices and VCS requirements. The verification protocol provides transparent means to record the observations by the verification team members and the non-conformities, if any. The verification protocol is an internal document, and available on request.

Duration of Verification:

Verification Contract	06/11/2018
On site verification	15/11/2018
Findings raised	27/11/2018
Draft Verification Report	01/02/2019
Final Verification Report	16/02/2019

2.2 Document Review

A desk review is undertaken, involving but not limited to,

- A review of the data and information presented to verify their completeness;
- A review of the monitoring plan and monitoring methodology, paying particular attention to the frequency of measurements, the quality of metering equipment including calibration requirements, and the quality assurance and quality control procedures;
- An evaluation of data management and the quality assurance and quality control system in the context of their influence on the generation and reporting of emission reductions.

The list of document reviewed is included in the Appendix 2: 'References'

2.3 Interviews

The site visit for this verification assessment was undertaken by the verification team. Summary of on-site activities are mentioned below;

Location	10 Moo 2, Asia Industrial Estate, Banchang, Rayong, Thailand
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Dates	15/11/2018
Key points discussed	Name of persons interviewed, Designation, Organization
• General aspects of the project • Project equipment operation and technical details • Changes since validation • Monitoring and measurement equipment • Remaining issues from previous verification • Calibration procedures • Quality management system • Involved personnel and responsibilities • Training and practice of the operational personnel • Implementation of the monitoring plan • Monitoring data management • Data uncertainty and residual risks • GHG calculation • Maintenance	Suwipa Rukwongtrakool, Project Manager, South Pole Carbon (Thailand) Co., Ltd. Supalerk Wongsiriwan, Improvement Manager, MTP HPPO Manufacturing Co.,Ltd. Chanisara Norasetkamon, Improvement Manager, MTP HPPO Manufacturing Co.,Ltd. Sutada Rumphoei, Junior project manager, South Pole Carbon (Thailand) Co., Ltd. Sirinut Raya, Project manager, South Pole Carbon (Thailand) Co., Ltd.

2.4 Site Inspections

A site visit is undertaken by members of verification team, involving but not limited to,

- An assessment of the implementation and operation of the project activity as per the registered VCS PD;
- A review of information flows for generating, aggregating and reporting the monitoring parameters;
- Interviews with relevant personnel to confirm that the operational and data collection procedures are implemented in accordance with the approved monitoring plan;
- A cross-check between information provided in the monitoring report and data from other sources such as plant log books, inventories, purchase records or similar data sources;
- A check of the monitoring equipments including calibration performance and observations of monitoring practices against the requirements of the registered VCS PD and the selected methodologies/23/;
- A review of calculations and assumptions made in determining the GHG data and emission reductions;
- An identification of quality control and quality assurance procedures in place to prevent or identify and correct any errors or omissions in the reported monitoring parameters.

2.5 Resolution of Findings

KBS applies the risk based approach aimed at focusing on high risk issues to the validation results whilst not omitting any part of the mandatory processes. A few discrepancies were found during the validation and the validation report was submitted to the project proponent, indicated under the titles corrective action requests (CARs) and clarification requests (CLs). CARs and CLs require the PP to take relevant actions. Criteria for judging items as CAR or CL are as follows:

Corrective action request (CAR):

- the project participants have made mistakes that will influence the ability of the project activity to achieve real, measurable additional emission reductions
- the Verified Carbon Standard's requirements have not been met, or
- there is a risk that emission reductions cannot be monitored or calculated.

Clarification request (CL):

- Information is insufficient or not sufficiently clear to determine whether the applicable VCS requirements have been met.

FARs is to be raised to highlight issues related to project implementation that require review during the first verification of the project activity. FARs does not relate to VCS requirements for registration.

CARs and CLs are to be resolved or closed out if the PP modifies the project description, rectifies the PD or provides adequate additional explanations or evidence that satisfies the concerns. If this is not completed, the project activity cannot be recommended for registration under VCS registry.

The project description document was revised addressing the CARs & CLs issued by KBS. After reviewing the revised and resubmitted project description/20/; resolving the CARs & CLs raised and outstanding concerns, KBS issues this final validation report and opinion.

03 CAR and 01 CL were found during verification and closed satisfactorily. The list of CARs/CLs raised and the response provided, the means of verification, reasons for their closure and references to correction in the MR are provided in appendix 4 of this report. The revised MR with changes incorporated as per the issues raised were rechecked with the documentary evidences and found to be inline.

2.5.1 Forward Action Requests

No FAR was raised during this monitoring period.

2.6 Eligibility for Validation Activities

KBS conducts the verification activity; the validation was performed by the other VVB and the separate validation report issued and approved by the VCS association. KBS has a valid UNFCCC accreditation in the sectoral scope from UNFCCC.

3 VALIDATION FINDINGS

Refer above section.

3.1 Participation under Other GHG Programs

PP does not apply for other GHG program as declared in the section 1.9 of the MR /02/.

3.2 Methodology Deviations

Verification team confirms that no methodology deviation was observed during this monitoring period.

3.3 Project Description Deviations

One deviation has been applied by the PP during this monitoring period. Description of the deviation and the assessment on conservativeness of the deviation is provided below.

Deviation 01:

Description of the deviation
<u>Description of deviation</u> The accuracy of the installed flow meter for monitoring the amount of Soly is not consistent with the accuracy identified in the registered PD, which is +/- 0.15% of reading. The actual accuracy in the technical specification document is +/-0.65% of reading for the same type and model of meter. This model of flow meter has been installed since the commissioning of project activity and used for measuring the amount of Soly for this entire monitoring period. This flow meter was checked during the validation site visit. The value mentioned in the registered PD may be a typographical error.

Compliance with the deviation

The technical specification of the installed flow meters provided by the manufacturer's is;

Brand	Rosemount
Type	Vortex
Model	8800DF020SA1N2D1E5T1CNQ4
Accuracy	+/- 0.65% of reading

Source : Product Data Sheet

The accuracy of this type of flow meter reported in this monitoring report is changed from +/- 0.15% to be +/- 0.65%.

This deviation does not impact the applicability of the methodology, additionality or the appropriateness of the baseline scenario, and the project remains in compliance with the applied methodology.

Assessment by the verification team

The deviation has been transparently described in section 2.2.2 of the MR.

The verification team is of the opinion that the approach followed by the PP is appropriately described and justified and the project remains in compliance with the VCS rules. It was a typo error in the VCS-PD which has been corrected. Verification team has checked the technical description of the equipment to confirm the same. The deviation does not overestimate the emission reduction and hence accepted to the verification team. Hence the deviation is accepted.

3.4 Grouped Project

The project is not a grouped project. Therefore this section is not applicable.

4 VERIFICATION FINDINGS

4.1 Project Implementation Status

The project activity is in operation stage as evidenced by the physical verification of the site.

All the physical components and project boundary are in conformity with the description in registered VCS PD/20/. The capacity of project equipments have been cross-checked during the on-site visit and found in-compliance with the registered VCS-PD/20/. On the basis of the on-site visit and the reviewed project documentation, the verification team confirms that the project was implemented and operated as described in the registered VCS PD/20/.

Full capacity run was achieved in 04/10/2011 as verified from supportive document /05/. Within this monitoring period, there were no significant occurrences of events, which affected the project activity within the project boundary. There is one deviation which has been addressed in the section 3.3 of this report and has been assessed by the verification team.

The project boundary in the validated VCS PD /20/ is in line with the actual project boundary.

Ownership and other programs:

The PP declared that the project is not registered any other mechanism apart VCS. Thus emission reductions generated by project will be solely claimed by PP and PP has right of use and hence accepted. Net GHG emission reductions or removals generated by this project will not be used for compliance with an emissions trading program or to meet binding limits on GHG emissions as the host country i.e. Thailand is not a participant in any emission trading programs or nor does it have any binding limits.

PP will not claim the carbon credits under any other GHG emission reduction scheme for the crediting period under VCS and PP has provided declaration on the same during the validation. Hence there is no possibility of double counting. Apart from VCS, it has neither applied nor been rejected under any other GHG program.

Management and operational system:

Verification team was able to verify that authorities and responsibilities for monitoring and reporting of all data related to the emission reductions were clearly defined for the monitoring period from 01/04/2014 to 31/12/2017.

The allocation of the responsibilities is documented in a written form and is followed as described in the registered VCS PD. Routines for the archiving of data are defined and documented. During the site visit all the required plant records were verified and found that the data is consistent with the provided in the final MR/02/ and ER sheets/04/.

The monitoring plan described in section 3.3 of the MR is confirmed to be correct. All the parameters of the monitoring plan are monitored using appropriate metering system.

The verification team has interviewed the plant personnel who are involved in the monitoring of the parameters that are used to determine the emission reductions of the VER project. It is confirmed based on the interviews that the plant's team is competent enough to monitor the parameters as described in the monitoring plan.

As discussed above, the verification team concludes that management and operational system of the project is implemented and operated well. Thus it ensures the quality of data which is required in calculating the emission reductions.

Implementation status of the monitoring plan:

Verification team confirms through on-site verification and from the document review, the actual monitoring system complies with the monitoring plan mentioned in the registered VCS-PD/20/.

During the verification, all relevant monitoring parameters of the registered monitoring plan have been verified with regard to the appropriateness of the verification method; the correctness of the values applied for ER calculation, the accuracy and applied QA/QC measures. All monitoring parameters have been measured / determined without material misstatements and are in line with all applicable standards and relevant requirements. It is confirmed that the monitoring mechanism is effective and reliable.

Therefore, from the document review and onsite verification, it is confirmed that all the parameters were monitored in accordance with the registered monitoring plan during the monitoring period. Following are the details of monitoring in accordance with the monitoring plan of the registered VCS PD:

Data and parameters monitored ex-post:

DATA/PARAMETER	PO _y
Data Unit	tonnes
Description	Quantity of PO produced in year y

Source of data to be used	Plant records, measured using Coriolis mass flowmeter /07/ and cross-checked with stock verification records /08/.			
Value data for the monitoring period	The lower and higher values from the plant records and stock records were applied in the calculation of baseline and project emissions for conservativeness as verified from the ER sheet /04/. The values have been verified from the PO-Monthly reports /07/ and found OK.			
	Monitoring period	Value		
		Monitored	Lower	Higher
	01/04/2014 to 31/12/2014	211,033	210,716	211,556
	01/01/2015 to 31/12/2015	423,741	423,106	424,682
	01/01/2016 to 31/12/2016	422,222	421,589	422,855
	01/01/2017 to 31/12/2017	426,048	425,271	426,687
Measuring frequency	Continuous monitoring, integrated daily and at least monthly recordings as per the registered plan /20/.			
Reporting frequency and recording procedure	Continuous monitoring, integrated daily and at least monthly recordings as per the registered plan /20/.			
Type of monitoring equipment	Tag no.		FT-4262-01	
	Equipment type		Coriolis mass flowmeter	
	Manufacturer		Endress+Hauser	
	Model		PROMASS 80F	
	Maximum permissible error		±0.15% ¹	
	Serial no.		D3037716000	
	Date of calibration		08/01/2019	
	Validity		07/01/2024	
	The monitoring details have been verified during the site visit and found OK.			
Is accuracy of the monitoring equipment as stated in the PDD?	The flow meter is of +/- 0.15% accuracy. The same was confirmed during the site visit and from manufacturers specification /12/. The accuracy class is as per industry standard which is accepted to the verification team.			
Calibration frequency/interval	The flow meter is calibrated once every 5 years, during shutdown as			

¹ https://portal.endress.com/wa001/dla/5000275/1921/000/01/TI101DEN_0210.pdf

	they are online which is found OK.
Is the calibration interval in line with the monitoring plan of the PDD?	The registered VCS PD does not specify the calibration interval and neither the manufacturer specification. The flow meter is calibrated once every 5 years, during shutdown which is accepted to the verification team. Further the values are cross verified with stock records /08/ and the most conservative value is applied for emission reduction calculations /04/. Since the latest calibration of the equipment was conducted on 08/01/2019 which was not in line with the calibration frequency, the measured values from 01/04/2014 to 31/12/2017 have been adjusted by applying the maximum permissible error ($\pm 0.15\%$) in a conservative manner which is found OK.
How were the values in the monitoring report verified and crosschecked?	The values have been verified from the PO-Monthly reports /07/ and found OK. Further the values are cross verified with stock records /08/ and the most conservative value is applied for emission reduction calculations /04/.
Does the data management (from monitoring equipment to emission reduction calculation) ensure correct transfer of data and reporting of emission reductions?	From meters all monitoring data are stored in logs and in electronic format as excel sheets and can an excel sheet can be retrieved for any said period and cross checked with sales/ production/ stock values. Hence the transfer of data is deemed accurate.
If only partial data are available because activity levels or non-activity parameters have not been monitored in accordance with the registered monitoring plan, has the most conservative assumption theoretically possible been applied or has a request for deviation been approved?	Not Applicable.

DATA/PARAMETER	Sol _y			
Data Unit	tonnes			
Description	Quantity of make-up solvent used in year y.			
Source of data to be used	Plant records, measured using vortex flow meter /07/ and cross-checked with stock verification records /08/.			
Value data for the monitoring period	The higher value between the plant records and stock records was applied in the calculation of project emissions for conservativeness as verified from the ER sheet /04/. The values have been verified from the MPG and MeOH_2014-2018 /07/ and found OK.			
	Monitoring period	Value		
		Monitored	Higher	
		01/04/2014 to 31/12/2014	10,986	11,224
		01/01/2015 to 31/12/2015	20,278	20,327

	01/01/2016 to 31/12/2016	21,068	21,205																
	01/01/2017 to 31/12/2017	18,098	18,615																
Measuring frequency	Continuous monitoring, integrated daily and at least monthly recordings as per the registered plan /20/.																		
Reporting frequency and recording procedure	Continuous monitoring, integrated daily and at least monthly recordings as per the registered plan /20/.																		
Type of monitoring equipment	<table><tr><td>Tag no.</td><td>FT-7409-02</td></tr><tr><td>Equipment type</td><td>Vortex flowmeter</td></tr><tr><td>Manufacturer</td><td>ROSEMOUNT</td></tr><tr><td>Model</td><td>8800DF020SA1N2D 1E5T1CNQ4</td></tr><tr><td>Maximum permissible error</td><td>±0.65%²</td></tr><tr><td>Serial no.</td><td>06015616</td></tr><tr><td>Date of calibrations</td><td>05/08/2010 08/12/2018</td></tr><tr><td>Validity</td><td>07/12/2023</td></tr></table> The monitoring details have been verified during the site visit and found OK.			Tag no.	FT-7409-02	Equipment type	Vortex flowmeter	Manufacturer	ROSEMOUNT	Model	8800DF020SA1N2D 1E5T1CNQ4	Maximum permissible error	±0.65% ²	Serial no.	06015616	Date of calibrations	05/08/2010 08/12/2018	Validity	07/12/2023
Tag no.	FT-7409-02																		
Equipment type	Vortex flowmeter																		
Manufacturer	ROSEMOUNT																		
Model	8800DF020SA1N2D 1E5T1CNQ4																		
Maximum permissible error	±0.65% ²																		
Serial no.	06015616																		
Date of calibrations	05/08/2010 08/12/2018																		
Validity	07/12/2023																		
Is accuracy of the monitoring equipment as stated in the PDD?	The flow meter is of +/- 0.65% accuracy. The same was confirmed during the site visit and from manufacturers specification /12/. The accuracy class is as per industry standard which is accepted to the verification team.																		
Calibration frequency/interval	The flow meter is calibrated once every 5 years, during shutdown as they are online which is found OK.																		
Is the calibration interval in line with the monitoring plan of the PDD?	The registered VCS PD does not specify the calibration interval and neither the manufacturer specification. The flow meter is calibrated once every 5 years, during shutdown which is accepted to the verification team. Further the values are cross verified with stock records /08/ and the most conservative value is applied for emission reduction calculations /04/. Since the calibration of the equipment was conducted on 08/12/2018 which was not in line with the calibration frequency, the measured values from 01/08/2015³ to 31/12/2017 have been adjusted by applying the maximum permissible error (±0.65%) in a conservative manner which is found OK.																		
How were the values in the	The values have been verified from the MPG and MeOH_2014-2018																		

² Page no.29 of the [technical specification](#)

³ The actual gap started from 05/08/2015. However, since the data was recorded as monthly basis, the error applied for the whole month of August 2015.

monitoring report verified and crosschecked?	/07/ and found OK. Further the values are cross verified with stock records /08/ and the most conservative value is applied for emission reduction calculations /04/.
Does the data management (from monitoring equipment to emission reduction calculation) ensure correct transfer of data and reporting of emission reductions?	From meters all monitoring data are stored in logs and in electronic format as excel sheets and can an excel sheet can be retrieved for any said period and cross checked with sales/ production/ stock values. Hence the transfer of data is deemed accurate.
If only partial data are available because activity levels or non-activity parameters have not been monitored in accordance with the registered monitoring plan, has the most conservative assumption theoretically possible been applied or has a request for deviation been approved?	Not Applicable.

DATA/PARAMETER	EF _{CO2,i,y}					
Data Unit	tCO ₂ /TJ					
Description	Weighted average CO ₂ emission factor of fossil fuel used during year y					
Source of data to be used	Default value from IPCC Table 2.3: Default emission factors for stationary combustion in manufacturing industries and construction /29/.					
Value data for the monitoring period	<table><tr><td>Fuel type</td><td>Value</td></tr><tr><td>Natural gas</td><td>56.1</td></tr></table>		Fuel type	Value	Natural gas	56.1
Fuel type	Value					
Natural gas	56.1					
Measuring frequency	Annually. The same is in line with the registered PD /20/ and the methodology applied /23/ hence accepted.					
Reporting frequency and recording procedure	Annually. The same is in line with the registered PD /20/ and the methodology applied /23/ hence accepted.					
Type of monitoring equipment	Not applicable					
Is accuracy of the monitoring equipment as stated in the PDD?	Not applicable					
Calibration frequency/interval	Not applicable					
Is the calibration interval in line with the monitoring plan of the PDD?	Not applicable					
How were the values in the monitoring report verified and crosschecked?	Not applicable					
Does the data management (from monitoring equipment to	Not applicable					

emission reduction calculation) ensure correct transfer of data and reporting of emission reductions?	
If only partial data are available because activity levels or non-activity parameters have not been monitored in accordance with the registered monitoring plan, has the most conservative assumption theoretically possible been applied or has a request for deviation been approved?	Not applicable

DATA/PARAMETER	$\eta_{Boiler,y}$
Data Unit	%
Description	Efficiency of the steam generating system
Source of data to be used	Not applicable
Value data for the monitoring period	This parameter is not considered in both baseline and project scenario, the same is in line with the registered VCS-PD /20/ and is hence accepted.
Measuring frequency	Not applicable
Reporting frequency and recording procedure	Not applicable
Type of monitoring equipment	Not applicable
Is accuracy of the monitoring equipment as stated in the PDD?	Not applicable
Calibration frequency/interval	Not applicable
Is the calibration interval in line with the monitoring plan of the PDD?	Not applicable
How were the values in the monitoring report verified and crosschecked?	Not applicable
Does the data management (from monitoring equipment to emission reduction calculation) ensure correct transfer of data and reporting of emission reductions?	Not applicable
If only partial data are available because activity levels or non-	Not applicable

activity parameters have not been monitored in accordance with the registered monitoring plan, has the most conservative assumption theoretically possible been applied or has a request for deviation been approved?	
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DATA/PARAMETER	SC _{HPPO,y}											
Data Unit	TJ											
Description	Thermal energy consumption in the PO production through HPPO process in year y											
Source of data to be used	Plant records. Steam consumption is converted into energy using enthalpy values and accounting for any condensate return. However as per the registered VCS PD /20/, since the steam is sourced from the cogeneration plants of Glow grid, the emissions get accounted in the electricity component therefore to avoid double counting and applying conservative principle the emission factor for steam has been considered as zero. Hence the emission from steam consumption is zero. The same is in line with the registered PD /20/ hence accepted. This parameter is not used for ER calculation.											
Value data for the monitoring period	As per the registered PD, the parameter was not considered in both baseline and project scenario. The Calculation has been verified in the ER sheet /04/ and found OK. <table><tr><th>Monitoring period</th><th>Value</th></tr><tr><td>01/04/2014 to 31/12/2014</td><td>582</td></tr><tr><td>01/01/2015 to 31/12/2015</td><td>1,178</td></tr><tr><td>01/01/2016 to 31/12/2016</td><td>1,183</td></tr><tr><td>01/01/2017 to 31/12/2017</td><td>1,151</td></tr></table>		Monitoring period	Value	01/04/2014 to 31/12/2014	582	01/01/2015 to 31/12/2015	1,178	01/01/2016 to 31/12/2016	1,183	01/01/2017 to 31/12/2017	1,151
Monitoring period	Value											
01/04/2014 to 31/12/2014	582											
01/01/2015 to 31/12/2015	1,178											
01/01/2016 to 31/12/2016	1,183											
01/01/2017 to 31/12/2017	1,151											
Measuring frequency	Calculated											
Reporting frequency and recording procedure	Steam reading is obtained as ton/hour. Temperature and pressure are averaged automatically by the system. Average pressure and temperature monthly readings are available hence enthalpy is calculated from steam table. Steam and electricity are supplied and billed by the Utility company.											
Type of monitoring equipment	<table><tr><td>Tag no.</td><td>FT-9500-01</td></tr><tr><td>Equipment type</td><td>Annubar flowmeter</td></tr><tr><td>Manufacturer</td><td>ROSEMOUNT</td></tr><tr><td>Model</td><td>3051SFADS240ZCHFS3A3D 0072AA1B2G9E1F2F0052</td></tr></table>		Tag no.	FT-9500-01	Equipment type	Annubar flowmeter	Manufacturer	ROSEMOUNT	Model	3051SFADS240ZCHFS3A3D 0072AA1B2G9E1F2F0052		
Tag no.	FT-9500-01											
Equipment type	Annubar flowmeter											
Manufacturer	ROSEMOUNT											
Model	3051SFADS240ZCHFS3A3D 0072AA1B2G9E1F2F0052											

	Maximum permissible error	±0.8% ⁴
	Serial no.	02209215
	Date of calibration	05/01/2011
	Tag no.	TT-9500-01
	Equipment type	RTD (PT100)
	Manufacturer	ABB
	Model	A5Y0W9S3D1D6P3D2L1H4 /OPT
	Maximum permissible error	±0.06%
	Serial no.	210000853587001
	Date of calibration	17/05/2011
	Tag no.	PT-9500-01
	Equipment type	Pressure transmitter
	Manufacturer	ROSEMOUNT
	Model	3051CA3A02A1BK6H2L4 T1P1CN
	Maximum permissible error	±1.0%
	Serial no.	2284871
	Date of calibration	17/05/2011
	The monitoring details have been verified during the site visit and found OK.	
Is accuracy of the monitoring equipment as stated in the PDD?	The same was confirmed during the site visit and from manufacturers specification /12/. The accuracy class is as per industry standard which is accepted to the verification team.	
Calibration frequency/interval	The meter is calibrated once every 5 years, during shutdown as they are online which is found OK.	
Is the calibration interval in line with the monitoring plan of the PDD?	The registered VCS PD does not specify the calibration interval and neither the manufacturer specification. The meter is calibrated once every 5 years, during shutdown which is accepted to the verification team. Further the values are cross verified with steam supply invoice and the most conservative value is applied.	
How were the values in the monitoring report verified and crosschecked?	PP has submitted the Steam supply invoices for the monitoring period. The validation team has verified the above documents and found ok.	
Does the data management	From meters all monitoring data are stored in logs and in electronic	

⁴ Page 4 of the [technical specification](#)

(from monitoring equipment to emission reduction calculation) ensure correct transfer of data and reporting of emission reductions?	format as excel sheets and can an excel sheet can be retrieved for any said period and cross checked with sales/ production/ stock values. Hence the transfer of data is deemed accurate.
If only partial data are available because activity levels or non-activity parameters have not been monitored in accordance with the registered monitoring plan, has the most conservative assumption theoretically possible been applied or has a request for deviation been approved?	Not Applicable.

DATA/PARAMETER	EC _{HPPO,y}																			
Data Unit	MWh																			
Description	Electrical energy consumption in the PO production through HPPO process in year y																			
Source of data to be used	Sourced from plant records, measured using electricity meters																			
Value data for the monitoring period	The higher value between the plant records /08/ and invoices /10/ was applied in the calculation of project emissions for conservativeness as verified from the ER sheet /04/. <table><tr><th rowspan="2">Monitoring period</th><th colspan="2">Value</th></tr><tr><th>Monitored</th><th>Higher</th></tr><tr><td>01/04/2014 to 31/12/2014</td><td>125,680</td><td>125,680</td></tr><tr><td>01/01/2015 to 31/12/2015</td><td>246,537</td><td>247,370</td></tr><tr><td>01/01/2016 to 31/12/2016</td><td>247,908</td><td>249,148</td></tr><tr><td>01/01/2017 to 31/12/2017</td><td>247,077</td><td>248,312</td></tr></table>			Monitoring period	Value		Monitored	Higher	01/04/2014 to 31/12/2014	125,680	125,680	01/01/2015 to 31/12/2015	246,537	247,370	01/01/2016 to 31/12/2016	247,908	249,148	01/01/2017 to 31/12/2017	247,077	248,312
Monitoring period	Value																			
	Monitored	Higher																		
01/04/2014 to 31/12/2014	125,680	125,680																		
01/01/2015 to 31/12/2015	246,537	247,370																		
01/01/2016 to 31/12/2016	247,908	249,148																		
01/01/2017 to 31/12/2017	247,077	248,312																		
Measuring frequency	Continuous monitoring, integrated daily and at least monthly recordings as per the registered plan /20/.																			
Reporting frequency and recording procedure	Continuous monitoring, integrated daily and at least monthly recordings as per the registered plan /20/.																			
Type of monitoring equipment	There are 4 power meters for measurement of electrical energy consumption. <table><tr><td>Tag no. / Serial no.</td><td>1) JT700211ACalc / BF0908074311 2) JT700214ACalc / BF0908074313 3) JT700220ACalc / BF0908074317</td></tr></table>			Tag no. / Serial no.	1) JT700211ACalc / BF0908074311 2) JT700214ACalc / BF0908074313 3) JT700220ACalc / BF0908074317															
Tag no. / Serial no.	1) JT700211ACalc / BF0908074311 2) JT700214ACalc / BF0908074313 3) JT700220ACalc / BF0908074317																			

		4) JT700223ACalc / BF0908074314
	Equipment type	7KG7750-0GA01-0AA0
	Manufacturer	SIEMENS
	Model	SIMEAS P50
	Maximum permissible error	±0.5%
	Date of calibrations	14/05/2010 13/07/2018
	Validity	12/07/2023
	The monitoring details have been verified during the site visit and found OK.	
Is accuracy of the monitoring equipment as stated in the PDD?	The meter is of +/- 0.5% accuracy. The same was confirmed during the site visit and from manufacturers specification /12/. The accuracy class is as per industry standard which is accepted to the verification team.	
Calibration frequency/interval	The meter is calibrated once every 5 years, during shutdown as they are online which is found OK.	
Is the calibration interval in line with the monitoring plan of the PDD?	The registered VCS PD does not specify the calibration interval and neither the manufacturer specification. The meter is calibrated once every 5 years, during shutdown which is accepted to the verification team. Further the values are cross verified with invoices /10/ and the most conservative value is applied for emission reduction calculations /04/. Since the calibration of the equipment was conducted on 13/07/2018 which was not in line with the calibration frequency, the measured values from 01/05/2015⁵ to 31/12/2017 have been adjusted by applying the maximum permissible error (±0.50%) in a conservative manner which is found OK.	
How were the values in the monitoring report verified and crosschecked?	The values have been verified from the supportive documents 08/ and found OK. Further the values are cross verified with invoices /10/ and the most conservative value is applied for emission reduction calculations /04/.	
Does the data management (from monitoring equipment to emission reduction calculation) ensure correct transfer of data and reporting of emission reductions?	From meters all monitoring data are stored in logs and in electronic format as excel sheets and can an excel sheet can be retrieved for any said period and cross checked with sales/ production/ stock values. Hence the transfer of data is deemed accurate.	
If only partial data are available because activity levels or non-	Not Applicable.	

⁵ The actual gap started from 14/05/2015. However, since the data was recorded as monthly basis, the error applied for the whole month of May 2015.

activity parameters have not been monitored in accordance with the registered monitoring plan, has the most conservative assumption theoretically possible been applied or has a request for deviation been approved?	
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DATA/PARAMETER	Q _{Propylene,y}																			
Data Unit	Tonnes																			
Description	Quantity of propylene used in year y																			
Source of data to be used	Plant records, measured using Coriolis mass flowmeter /07/ and cross-checked with stock verification records /08/.																			
Value data for the monitoring period	The higher value between the plant records and stock records was applied in the calculation of project emissions for conservativeness as verified from the ER sheet /04/. <table><tr><th rowspan="2">Monitoring period</th><th colspan="2">Value</th></tr><tr><th>Monitored</th><th>Higher</th></tr><tr><td>01/04/2014 to 31/12/2014</td><td>168,009</td><td>168,009</td></tr><tr><td>01/01/2015 to 31/12/2015</td><td>332,487</td><td>332,785</td></tr><tr><td>01/01/2016 to 31/12/2016</td><td>333,681</td><td>334,964</td></tr><tr><td>01/01/2017 to 31/12/2017</td><td>335,963</td><td>337,443</td></tr></table>			Monitoring period	Value		Monitored	Higher	01/04/2014 to 31/12/2014	168,009	168,009	01/01/2015 to 31/12/2015	332,487	332,785	01/01/2016 to 31/12/2016	333,681	334,964	01/01/2017 to 31/12/2017	335,963	337,443
Monitoring period	Value																			
	Monitored	Higher																		
01/04/2014 to 31/12/2014	168,009	168,009																		
01/01/2015 to 31/12/2015	332,487	332,785																		
01/01/2016 to 31/12/2016	333,681	334,964																		
01/01/2017 to 31/12/2017	335,963	337,443																		
Measuring frequency	Continuous monitoring, integrated daily and at least monthly recordings as per the registered plan /20/.																			
Reporting frequency and recording procedure	Continuous monitoring, integrated daily and at least monthly recordings as per the registered plan /20/.																			
Type of monitoring equipment	<table><tr><td>Tag no.</td><td>FT-1164-01</td></tr><tr><td>Equipment type</td><td>Coriolis mass flowmeter</td></tr><tr><td>Manufacturer</td><td>Endress+Hauser</td></tr><tr><td>Model</td><td>PROMASS 80F</td></tr><tr><td>Maximum permissible error</td><td>±0.15%⁶</td></tr><tr><td>Serial no.</td><td>D3036216000</td></tr><tr><td>Date of calibration</td><td>04/06/2010</td></tr></table>			Tag no.	FT-1164-01	Equipment type	Coriolis mass flowmeter	Manufacturer	Endress+Hauser	Model	PROMASS 80F	Maximum permissible error	±0.15% ⁶	Serial no.	D3036216000	Date of calibration	04/06/2010			
Tag no.	FT-1164-01																			
Equipment type	Coriolis mass flowmeter																			
Manufacturer	Endress+Hauser																			
Model	PROMASS 80F																			
Maximum permissible error	±0.15% ⁶																			
Serial no.	D3036216000																			
Date of calibration	04/06/2010																			

⁶ Page no.17 of the [technical specification](#)

		10/03/2018
	Validity	09/03/2023
	The monitoring details have been verified during the site visit and found OK.	
Is accuracy of the monitoring equipment as stated in the PDD?	The flow meter is of +/- 0.15% accuracy. The same was confirmed during the site visit and from manufacturers specification /12/. The accuracy class is as per industry standard which is accepted to the verification team.	
Calibration frequency/interval	The flow meter is calibrated once every 5 years, during shutdown as they are online which is found OK.	
Is the calibration interval in line with the monitoring plan of the PDD?	The registered VCS PD does not specify the calibration interval and neither the manufacturer specification. The flow meter is calibrated once every 5 years, during shutdown which is accepted to the verification team. Further the values are cross verified with stock records /08/ and the most conservative value is applied for emission reduction calculations /04/. Since the calibration of the equipment was conducted on 10/03/2018 which was not in line with the calibration frequency, the measured values from 01/06/2015⁷ to 31/12/2017 have been adjusted by applying the maximum permissible error ($\pm 0.15\%$) in a conservative manner. The details can be found in the calculation sheet which is found OK.	
How were the values in the monitoring report verified and crosschecked?	The values have been verified from the PO-Monthly reports /07/ and found OK. Further the values are cross verified with stock records /08/ and the most conservative value is applied for emission reduction calculations /04/.	
Does the data management (from monitoring equipment to emission reduction calculation) ensure correct transfer of data and reporting of emission reductions?	From meters all monitoring data are stored in logs and in electronic format as excel sheets and can an excel sheet can be retrieved for any said period and cross checked with sales/ production/ stock values. Hence the transfer of data is deemed accurate.	
If only partial data are available because activity levels or non-activity parameters have not been monitored in accordance with the registered monitoring plan, has the most conservative assumption theoretically possible been applied or has a request for deviation been approved?	Not Applicable.	

⁷ The actual gap started from 04/06/2015. However, since the data was recorded as monthly basis, the error applied for the whole month of June 2015.

DATA/PARAMETER	Q _{By-product,y}																										
Data Unit	Tonnes																										
Description	Quantity of by-product produced in year y																										
Source of data to be used	Plant records, measured using Ultrasonic meter /07/ and cross-checked with stock verification records /08/.																										
Value data for the monitoring period	The lower value between the plant records and stock records was applied in the calculation of project emissions for conservativeness as verified from the ER sheet /04/. <table><tr><th rowspan="2">Monitoring period</th><th colspan="2">Value</th></tr><tr><th>Monitored</th><th>Lower</th></tr><tr><td>01/04/2014 to 31/12/2014</td><td>1,478</td><td>1,408</td></tr><tr><td>01/01/2015 to 31/12/2015</td><td>4,503</td><td>3,942</td></tr><tr><td>01/01/2016 to 31/12/2016</td><td>4,631</td><td>4,542</td></tr><tr><td>01/01/2017 to 31/12/2017</td><td>5,318</td><td>5,244</td></tr></table>			Monitoring period	Value		Monitored	Lower	01/04/2014 to 31/12/2014	1,478	1,408	01/01/2015 to 31/12/2015	4,503	3,942	01/01/2016 to 31/12/2016	4,631	4,542	01/01/2017 to 31/12/2017	5,318	5,244							
Monitoring period	Value																										
	Monitored	Lower																									
01/04/2014 to 31/12/2014	1,478	1,408																									
01/01/2015 to 31/12/2015	4,503	3,942																									
01/01/2016 to 31/12/2016	4,631	4,542																									
01/01/2017 to 31/12/2017	5,318	5,244																									
Measuring frequency	Continuous monitoring, integrated daily and at least monthly recordings as per the registered plan /20/.																										
Reporting frequency and recording procedure	Continuous monitoring, integrated daily and at least monthly recordings as per the registered plan /20/.																										
Type of monitoring equipment	<table><tr><td>Tag no.</td><td colspan="2">FIT-7220-01</td></tr><tr><td>Equipment type</td><td colspan="2">Ultrasonic</td></tr><tr><td>Manufacturer</td><td colspan="2">KROHNE</td></tr><tr><td>Model</td><td colspan="2">UFS3000</td></tr><tr><td>Maximum permissible error</td><td colspan="2">±0.5%⁸</td></tr><tr><td>Serial no.</td><td colspan="2">A1071567</td></tr><tr><td>Date of calibration</td><td colspan="2">17/05/2010 06/12/2018</td></tr><tr><td>Validity</td><td colspan="2">05/12/2023</td></tr></table> The monitoring details have been verified during the site visit and found OK.			Tag no.	FIT-7220-01		Equipment type	Ultrasonic		Manufacturer	KROHNE		Model	UFS3000		Maximum permissible error	±0.5% ⁸		Serial no.	A1071567		Date of calibration	17/05/2010 06/12/2018		Validity	05/12/2023	
Tag no.	FIT-7220-01																										
Equipment type	Ultrasonic																										
Manufacturer	KROHNE																										
Model	UFS3000																										
Maximum permissible error	±0.5% ⁸																										
Serial no.	A1071567																										
Date of calibration	17/05/2010 06/12/2018																										
Validity	05/12/2023																										
Is accuracy of the monitoring equipment as stated in the PDD?	The flow meter is of +/- 0.5% accuracy. The same was confirmed during the site visit and from manufacturers specification /12/. The accuracy class is as per industry standard which is accepted to the																										

⁸ Page no.4 of the [technical specification](#)

	verification team.
Calibration frequency/interval	The flow meter is calibrated once every 5 years, during shutdown as they are online which is found OK.
Is the calibration interval in line with the monitoring plan of the PDD?	The registered VCS PD does not specify the calibration interval and neither the manufacturer specification. The meter is calibrated once every 5 years, during shutdown which is accepted to the verification team. Further the values are cross verified with stock records /08/ and the most conservative value is applied for emission reduction calculations /04/. Since the calibration of the equipment was conducted on 06/12/2018 which was not in line with the calibration frequency, the measured values from 01/05/2015⁹ to 31/12/2017 have been adjusted by applying the error identified in calibration test ($\pm 1.406\%$) in a conservative manner which is found ok.
How were the values in the monitoring report verified and crosschecked?	The values have been verified from the MPG and MeOH_2014-2018 /07/ and found OK. Further the values are cross verified with stock records /08/ and the most conservative value is applied for emission reduction calculations /04/.
Does the data management (from monitoring equipment to emission reduction calculation) ensure correct transfer of data and reporting of emission reductions?	From meters all monitoring data are stored in logs and in electronic format as excel sheets and can an excel sheet can be retrieved for any said period and cross checked with sales/ production/ stock values. Hence the transfer of data is deemed accurate.
If only partial data are available because activity levels or non-activity parameters have not been monitored in accordance with the registered monitoring plan, has the most conservative assumption theoretically possible been applied or has a request for deviation been approved?	Not Applicable.

DATA/PARAMETER	FC _{i,y}
Data Unit	MMBTU (volume unit)
Description	Quantity of NG combusted in the incinerator during the year y
Source of data to be used	NG supplied by PTT (Supplier). Measured through turbine meter installed on PTT skid.
Value data for the monitoring period	The higher value between the plant records and stock records was applied in the calculation of project emissions for conservativeness as

⁹ The actual gap started from 17/05/2015. However, since the data was recorded as monthly basis, the error applied for the whole month of May 2015.

	verified from the ER sheet /04/.																	
	<table><tr><th rowspan="2">Monitoring period</th><th colspan="2">Value</th></tr><tr><th>Monitored¹⁰</th><th>Higher</th></tr><tr><td>01/04/2014 to 31/12/2014</td><td>104,727</td><td>143,227</td></tr><tr><td>01/01/2015 to 31/12/2015</td><td>302,713</td><td>384,265</td></tr><tr><td>01/01/2016 to 31/12/2016</td><td>278,475</td><td>363,932</td></tr><tr><td>01/01/2017 to 31/12/2017</td><td>241,549</td><td>338,891</td></tr></table>	Monitoring period	Value		Monitored ¹⁰	Higher	01/04/2014 to 31/12/2014	104,727	143,227	01/01/2015 to 31/12/2015	302,713	384,265	01/01/2016 to 31/12/2016	278,475	363,932	01/01/2017 to 31/12/2017	241,549	338,891
Monitoring period	Value																	
	Monitored ¹⁰	Higher																
01/04/2014 to 31/12/2014	104,727	143,227																
01/01/2015 to 31/12/2015	302,713	384,265																
01/01/2016 to 31/12/2016	278,475	363,932																
01/01/2017 to 31/12/2017	241,549	338,891																
Measuring frequency	The meter belongs to PTT and installed on PTT skid.																	
Reporting frequency and recording procedure	The meter belongs to PTT and installed on PTT skid.																	
Type of monitoring equipment	There are 2 meters belongs to PTT company (natural gas supplier) <table><tr><td>Tag no. / Serial no.</td><td>1) 330-FY-6502A / 3401877930 2) 330-FY-6502B / 3401117178</td></tr><tr><td>Equipment type</td><td>Turbine meter with gas volume converter</td></tr><tr><td>Manufacturer</td><td>Itron</td></tr><tr><td>Maximum permissible error</td><td>±0.2%¹¹</td></tr><tr><td>Date of calibrations</td><td>20/07/2017 19/07/2018</td></tr></table>	Tag no. / Serial no.	1) 330-FY-6502A / 3401877930 2) 330-FY-6502B / 3401117178	Equipment type	Turbine meter with gas volume converter	Manufacturer	Itron	Maximum permissible error	±0.2% ¹¹	Date of calibrations	20/07/2017 19/07/2018							
Tag no. / Serial no.	1) 330-FY-6502A / 3401877930 2) 330-FY-6502B / 3401117178																	
Equipment type	Turbine meter with gas volume converter																	
Manufacturer	Itron																	
Maximum permissible error	±0.2% ¹¹																	
Date of calibrations	20/07/2017 19/07/2018																	
Is accuracy of the monitoring equipment as stated in the PDD?	The meter is of +/- 0.2% accuracy. The accuracy class is as per industry standard which is accepted to the verification team.																	
Calibration frequency/interval	The meter is calibrated once every 5 years, during shutdown as they are online which is found OK.																	
Is the calibration interval in line with the monitoring plan of the PDD?	The registered VCS PD does not specify the calibration interval and neither the manufacturer specification. The meter is calibrated once every 5 years, during shutdown which is accepted to the verification team. Further the values are cross verified with gas invoices /11/ and the most conservative value is applied for emission reduction calculations /04/.																	

¹⁰ The value was monitored in Nm³ unit. The factor of 0.0411 MMBTU/Nm³ is used to convert the value in Nm³ to MMTBU unit.

¹¹ Page no.2 of the [technical specification](#)

	Since the calibration of the equipment was conducted on 20/07/2017 which was not in line with the calibration frequency, the measured values from 01/04/2014 to 31/07/2017 ¹² have been adjusted by applying the maximum permissible error ($\pm 0.2\%$) in a conservative manner. The details can be found in the calculation sheet which is found OK.
How were the values in the monitoring report verified and crosschecked?	The values have been verified from the supportive documents 08/ and found OK. Further the values are cross verified with gas invoices /11/ and the most conservative value is applied for emission reduction calculations /04/.
Does the data management (from monitoring equipment to emission reduction calculation) ensure correct transfer of data and reporting of emission reductions?	From meters all monitoring data are stored in logs and in electronic format as excel sheets and can an excel sheet can be retrieved for any said period and cross checked with sales/ production/ stock values. Hence the transfer of data is deemed accurate.
If only partial data are available because activity levels or non-activity parameters have not been monitored in accordance with the registered monitoring plan, has the most conservative assumption theoretically possible been applied or has a request for deviation been approved?	Not Applicable.

DATA/PARAMETER	COEF _{i,y}
Data Unit	tCO ₂ /t of Natural gas
Description	CO ₂ emission coefficient of Natural gas
Source of data to be used	Sourced from IPCC Data /29/
Value data for the monitoring period	2.6928
Measuring frequency	Annually. The same is in line with the methodology requirement and is hence accepted.
Reporting frequency and recording procedure	Annually. The same is in line with the methodology requirement and is hence accepted.
Type of monitoring equipment	Not applicable
Is accuracy of the monitoring equipment as stated in the PDD?	Not applicable

¹² The actual gap was up to 19/07/2017. However, since the data was recorded as monthly basis, the error applied for the whole month of July 2017.

Calibration frequency/interval	Not applicable
Is the calibration interval in line with the monitoring plan of the PDD?	Not applicable
How were the values in the monitoring report verified and crosschecked?	Not applicable
Does the data management (from monitoring equipment to emission reduction calculation) ensure correct transfer of data and reporting of emission reductions?	Not applicable
If only partial data are available because activity levels or non-activity parameters have not been monitored in accordance with the registered monitoring plan, has the most conservative assumption theoretically possible been applied or has a request for deviation been approved?	Not applicable

Remaining Issues from Validation or Previous Verification:

From the review of validation report and the previous (1st) verification report, Verification team has found that there are no remaining FAR from previous verification (1st periodic verification).

4.2 Accuracy of GHG Emission Reduction and Removal Calculations

The verification team has reviewed the emission reduction (ER) spread sheet /04/ and checked all the formulae and found they are correct and inline with the monitoring plan of the registered VCS PD /20/ and the applied monitoring methodologies.

All the monitored parameters are described above in section 4.1. All the ex-ante parameters which are used in the calculation of emission reduction are presented in section 3.1 of the MR transparently. It is confirmed that all the ex-ante parameters have been correctly used in the emission reduction calculation.

Baseline emissions:

It is noted that the formula and calculation used for baseline emission calculation in the monitoring report and ER sheet is in compliance with the registered VCS PD. The default values and data used in the monitoring report /02/ is in-line with the registered PD/20/. Hence, accepted.

BE _y	Unit	2014	2015	2016	2017
BE _{Upstream,y}	tCO ₂	290,153	582,609	580,520	585,590
BE _{Process,y}	tCO ₂	10,773	21,633	21,555	21,744
BE _y	tCO ₂	300,926	604,242	602,075	607,334

Project Emissions:

It is noted that the formula and calculation used for project emission calculation in the monitoring report and ER sheet is in compliance with the registered VCS PD. The default values and data used in the monitoring report /02/ is in-line with the registered PD/20/. Hence, accepted.

PE _y	Unit	2014	2015	2016	2017
PE _{Upstream,y}	tCO ₂	69,581	138,994	138,695	139,089
PE _{Process,y}	tCO ₂	134,206	253,318	263,491	256,212
PE _y	tCO ₂	203,787	392,312	402,186	395,301

Leakage:

No leakage emissions are considered consistent with the methodology /23/ and the registered VCS PD /20/.

The following are the ex-ante parameters used in the ER calculation which are in compliance with registered VCS PD/20/:

S. No.	Parameter	Description	Value	Unit
1	ec _{Chlor-Alkali, y}	Energy consumption per tonne of Cl ₂ production in year y	2.2	MWh/tCl ₂
2	SSC _{CHPO}	Specific thermal energy consumption ratio in PO production through the CHPO-chlor-alkali process.	0.003864	TJ/tonne of PO
3	SEC _{CHPO}	Specific electrical energy consumption ratio in PO production through the CHPO-chlor-alkali process.	0.100	MWh/tonne of PO
4	pe _{HP}	Quantity of CO ₂ that would be emitted per tonne of H ₂ O ₂	0.533	tCO ₂ /tH ₂ O ₂
5	pe _{Sol}	Quantity of CO ₂ emitted per tonne of solvent	0.310	tCO ₂ /tonne of solvent
6	ca _{Waste,Baseline}	Carbon amount in the waste stream combusted in the incinerator in the baseline per tonne of PO	-	tC/tonne of PO
7	fc _{i,Baseline}	Quantity of fossil fuel combusted in the incinerator in the baseline per tonne of PO production	-	Ratio
8	EF _{EL,y}	Emission factor for electricity generation in year y	0.5113	tCO ₂ /MWh

The verified emission reductions are as follows:

Year	Baseline emissions or removals (tCO ₂ e)	Project emissions or removals (tCO ₂ e)	Leakage emissions (tCO ₂ e)	Net GHG emission reductions or removals (tCO ₂ e)
01/04/2014 to 31/12/2014	300,926	203,787	0	97,139
01/01/2015	604,242	392,312	0	211,930

to 31/12/2015				
01/01/2016 to 31/12/2016	602,075	402,186	0	199,889
01/01/2017 to 31/12/2017	607,334	395,301	0	212,033
Total	2,114,577	1,393,586	0	720,991

The detailed emission reduction calculation is presented in the ER spread sheet/04/. All the formulae and the calculation procedure were checked by the verification team. It was observed that the emission reduction was determined in a conservative manner.

4.3 Quality of Evidence to Determine GHG Emission Reductions and Removals

During the verification site visit, all relevant documents were checked to assess the correctness and quality of data submitted by the project participants, which are used to determine emission reductions. All records needed for monitoring are archived in line with the requirements of the registered monitoring plan. No significant, lack of evidence and missing data were detected during onsite verification. Hence, the verification team confirms that the monitoring system ensures required quality of the monitoring system to ensure the quality of the monitored data. All internal data are subjected to QA/QC measures.

Purchased Utilities including Electricity, steam and natural gas measured using calibrated meters and cross checked with supplier invoices and the most conservative value /04/ is taken for emission reduction calculations.

The verification team has cross checked production records, stock verification records and monthly invoices against the values applied in the emission reduction calculations and found to be in order.

It was verified through onsite interviews that the plant's team involved in the monitoring of project activity is well experienced. Hence, the verification team concludes that competent staff is employed by the project proponent to carry out the relevant tasks with sufficient accuracy.

4.4 Non-Permanence Risk Analysis

Not Applicable to the project activity

5 SAFEGUARDS

5.1 No Net Harm

The project activity has no potential negative environment and social-economic impacts. Assessment team confirms it based on its on-site visit, document review and local & sectoral expertise.

5.2 Local Stakeholder Consultation

The local stakeholder consultation meeting for the project activity has been conducted on 3rd of February 2010 and the process was validated during the registration of project activity under VCS. VCS validation report verified to confirm the same. The invitation letter was sent out as well as announcement made publicly. In addition, the project also organized several following up group consultation in order to make sure that most of relevant stakeholders had expressed their opinion and concern on the project. The PP had invited identified stakeholders well in advance. The stakeholder meeting process is described in the section 6 of the registered VCS PD in detail. Further the verification team has interviewed the local stakeholders during the on-site visit for this verification and could not find any negative impact out of the project activity.

6 VERIFICATION CONCLUSION

KBS Certification Services Pvt. Ltd. has been contracted by 'South Pole Carbon (Thailand) Company Limited' to undertake independent 2nd periodic verification and certification for the greenhouse gas (GHG) emission reductions reported from "Reduction of GHG Emissions in Propylene Oxide Production at MTP HPPO Manufacturing Co., Ltd.", for the monitoring period 01/04/2014 to 31/12/2017 (including both the days).

The verification is based on the registered VCS PD and the monitoring report for this project activity. Our verification approach was based on the requirements as defined under the Kyoto Protocol, Marrakech accord, as well as those defined by the CDM Executive Board and the VCS Standard Version 3.7.

The management of 'MTP HPPO Manufacturing Co.,Ltd' and "South Pole Carbon (Thailand) Co., Ltd." is responsible for the preparation of the GHG emissions data and the reported GHG emissions reductions on the basis set out within the project Final Monitoring Report Version 03 and dated 31/01/2019. The calculation and determination of GHG emission reductions from the project is the responsibility of the management of 'MTP HPPO Manufacturing Co.,Ltd' and "South Pole Carbon (Thailand) Co., Ltd.". The development and maintenance of records and reporting procedures are in accordance with the Monitoring Report Version 03 and dated 31/01/2019.

It is our responsibility to express an independent GHG verification opinion on the GHG emissions and on the calculation of GHG emission reductions from the project for the period 01/04/2014 to 31/12/2017 based on the reported emission reductions in the Final Monitoring Report Version 03 and dated 31/01/2019 for the same period.

As a result of the verification, the verification team confirms that:

- All operations of the project are implemented and installed as planned and described in the project description.
- The monitoring system is in place and functional.
- The installed equipment essential for generating emission reductions runs reliably.
- The GHG emission reductions are calculated without material misstatements in a conservative and appropriate manner.

Based on an understanding of the risks associated with reporting GHG emissions data and the controls in place to mitigate these, KBS planned and performed our work to obtain the information and explanations that we considered necessary to provide sufficient evidence for us to give reasonable assurance that this reported amount of GHG emission reductions for the period is fairly stated.

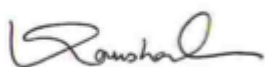
Verification period: From [01-04-2014] to [31-12-2017]

Verified GHG emission reductions and removals in the above verification period:

Year	Net GHG emission reductions or removals (tCO ₂ e)
2014 (01/04/2014 to 31/12/2014)	97,139
2015 (01/01/2015 to 31/12/2015)	211,930
2016 (01/01/2016 to 31/12/2016)	199,889
2017 (01/01/2017 to 31/12/2017)	212,033
Total	720,991

Location: Faridabad

Date: 16/02/2019



Authorized Signatory: Kaushal Goyal
Designation: Managing Director
KBS Certification Services Pvt. Ltd.

APPENDIX 1: ABBREVIATIONS

Abbreviations	Full texts
CAR	Corrective Action Request
CDM	Clean Development Mechanism
CDM EB	CDM Executive Board
CL	Clarification request
CO ₂	Carbon dioxide
CO ₂ e	Carbon dioxide equivalent
COD	Chemical Oxygen Demand
DOE	Designated Operational Entity
EB	Executive Board
ER	Emission Reduction
FAR	Forward Action Request
GHG	Greenhouse Gas(es)
MP	Monitoring Plan
MR	Monitoring Report
PD	Power Density
PP	Project Participant
QA/QC	Quality Assurance / Quality Control
UNFCCC	United Nations Framework Convention on Climate Change
VCS	Verified Carbon Standard
VCSA	VCS Association
VCS PD	VCS Project Design document

VCU	Verified Carbon Unit
VVS	Validation And Verification Standard

APPENDIX 2: REFERENCES

S. No.	Name of document	date
/1/	Draft Monitoring Report	Version 01, dated 12/11/2018
/2/	Final Monitoring Report	Version 03, dated 31/01/2019
/3/	Draft ER sheet	Corresponding to MR version 01
/4/	Final ER sheet	Corresponding to MR version 03
/5/	Commissioning of plant	Dated 04/10/2011
/6/	Log sheets corresponding all the monitoring parameters	-
/7/	PO production report for the monitoring period: - PO Monthly Report - MPG and MeOH_2014-2018 - External vendor utility allocation	-
/8/	PO Stock checking report for the monitoring period: - PO Yield and Inventory - Raw data from Energy consumption	-
/9/	Data cross check report for the monitoring period	-
/10/	Glow Energy Public Company Limited: Electricity supply invoices for the monitoring period	-
/11/	PTT Public Company Limited: Natural Gas supply invoices for the monitoring period	-
/12/	Technical specification of the monitoring equipments	-
/13/	Calibration certificates of all the monitoring equipment's	-

	covering the monitoring period	
/14/	MTP HPPO Manufacturing Co.,Ltd: Overall Material Flow & Organization chart	-
/15/	Organization structure	-
/16/	Operational license for the project activity	-
/17/	Company registration certificate	-
/18/	Shutdown Plan for the calibration frequency	
/19/	CDM-EB: Clean Development Mechanism Validation and Verification Standard for project activity	Version 02.0
/20/	Registered VCS PD for the project "Reduction of GHG Emissions in Propylene Oxide Production at MTP HPPO Manufacturing Co., Ltd."	Version 02, dated 22/09/2014
/21/	RINA SERVICES S.P.A: Validation report for the project "Reduction of GHG Emissions in Propylene Oxide Production at MTP HPPO Manufacturing Co., Ltd.", report number N° 2013-IQ-29-MD issued on 13-November-2014	Dated 13-November-2014
/22/	RINA SERVICES S.P.A: Verification report for the project "Reduction of GHG Emissions in Propylene Oxide Production at MTP HPPO Manufacturing Co., Ltd.", report number 2014-IQ-05-MD issued on 27-July-2016	Dated 27-July-2016
/23/	Approved VCS Methodology VM0023, "Reduction of GHG Emissions in Propylene Oxide Production", version 1.0	Version 1.0
/24/	VCS Verified Carbon Standard: VCS Program Guide, VCS Version 03, v3.7	21 June 2017
/25/	VCS Verified Carbon Standard: VCS Standard, VCS Version 03, v3.7	21 June 2017
/26/	VCS Verified Carbon Standard: VCS Verification Report Template Version 3.4	19 October 2016
/27/	VCS Verified Carbon Standard: VCS Guidance, Validation and Verification Manual, Version 3.2	19 October 2016
/28/	VCS Verified Carbon Standard: VCS Monitoring Report Template Version 3.4	19 October 2016

/29/	IPCC: 2006 IPCC Guidelines for National Greenhouse Gas Inventories, available at weblink http://www.ipcc-nggip.iges.or.jp/public/2006gl/	-
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APPENDIX 3: COMPETENCE OF TEAM MEMBERS AND TECHNICAL REVIEWERS

Personnel Name:		Chetan Swaroop Sharma	
Qualified to work as:			
Team Leader	☒	Technical Expert	☒
Validator/Verifier	☒	Financial Expert	☒
Technical Reviewer	☒	Local Expert (India)	☒
Area(s) of Technical Expertise			
Sectoral Scope	Technical Area		
Energy industries (renewable/non-renewable sources)	TA 1.1: Thermal energy generation from fossil fuels and biomass including thermal electricity from solar		
	TA 1.2: Energy generation from renewable energy sources		
Energy Demand	TA 3.1. Energy demand		
Waste handling and disposal	TA 13.1. Solid waste and wastewater TA 13.2. Manure		
Approved by (Manager C & T)	Sanjay Kandari		
Approval date:	01/05/2017		

Personnel Name:		R. A. Sinha	
Qualified to work as:			
Team Leader	☐	Technical Expert	☒
Validator/Verifier	☐	Financial Expert	☐
Technical Reviewer	☐	Local Expert	☐
Area(s) of Technical Expertise			
Sectoral Scope	Technical Area		
Chemical Industry	TA 5.1: Chemical process industries		
Solvents use	TA 12.1: Chemical process industries		
Approved by (Manager C & T)	Sanjay Kandari		
Approval date:	26/09/2016		

Personnel Name:		Vikas Kumar	
Qualified to work as:			
Team Leader	☐	Technical Expert	☒
Validator/Verifier	☐	Financial Expert	☐
Technical Reviewer	☐	Local Expert	☐
Area(s) of Technical Expertise			
Sectoral Scope		Technical Area	
Chemical Industry		TA 5.1: Chemical process industries	
Solvents use		TA 12.1: Chemical process industries	
Approved by (Manager C & T)		Sanjay Kandari	
Approval date:		26/09/2016	

Personnel Name:		Rohit Badaya	
Qualified to work as:			
Team Leader	☒	Technical Expert	☒
Validator/Verifier	☒	Financial Expert	☒
Technical Reviewer	☒	Local Expert (India)	☒
Area(s) of Technical Expertise			
Sectoral Scope		Technical Area	
Energy industries (renewable/non-renewable sources)		TA 1.1: Thermal energy generation from fossil fuels and biomass including thermal electricity from solar	
		TA 1.2: Energy generation from renewable energy sources	
Energy demand		TA 3.1. Energy Demand	
Waste Handling and Disposal		TA 13.1 Solid waste and wastewater	
		TA 13.2 Manure	
Approved By		Manager Competency & Training	
Approval date:		16/10/2017	

APPENDIX 4: CLARIFICATION REQUESTS, CORRECTIVE ACTION REQUESTS AND FORWARD ACTION REQUESTS

Table 1. Remaining FAR from validation and/or previous verifications

No pending FAR from validation and/or previous verification

FAR ID	Xx	Section no.	-	Date: DD/MM/YYYY
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Description of FAR	
Project participant response	Date: DD/MM/YYYY
Documentation provided by project participant	
DOE assessment	Date: DD/MM/YYYY

Table 2. CL from this verification

CL ID	01	Section no.	-	Date: 27/11/2018
Description of CL				
Under section 3.2 of the submitted monitoring report, PP need to justify the mentioned calibration frequency of the monitoring equipment's i.e. once in 8 years.				
Project participant response				Date: 21/01/2019
The calibration frequency of the monitoring equipment has been scheduled according to the shutdown plan of HPPO plant which is every 60 months or 5 years in line with the previous verification. The same has been revised under section 3.2 of the revised MR.				
Documentation provided by project participant				
The revised monitoring report date 31/01/2019 version 03				
DOE assessment				Date: 01/02/2019
The Monitoring report has been updated /02/ and found OK. Verification team has checked shutdown plan /18/ and found the calibration frequency of once in 5 years acceptable. Hence this CL is closed.				

Table 3. CAR from this verification

CAR ID	01	Section no.	-	Date: 27/11/2018
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Description of CAR	
Section 3.16.6 of the VCS Standard, v3.7 requires that the project proponent “adhere to all instructional text” within the monitoring report template. Report ID on Page 1 of the submitted monitoring report is not filled.	
Project participant response	Date: 21/01/2019
The report ID has been inserted on page 1 of the monitoring report.	
Documentation provided by project participant	
The revised monitoring report date 31/01/2019 version 03	
DOE assessment	Date: 01/02/2019
Correction has been done in the revised MR /02/ and found OK. Hence this CAR is closed.	

CAR ID	02	Section no.	-	Date: 27/11/2018
Description of CAR				
Section 3.16.6 of the VCS Standard, v3.7 requires that the project proponent “adhere to all instructional text” within the monitoring report template. Section 1.9 of the VCS Monitoring Report Template, v3.4 requires that the project proponent “indicate whether the project has sought or received another form of GHG-related environmental credit, including renewable energy certificates, during this monitoring period” and “indicate whether the project is registered under any other GHG programs”. However section 1.9 of the submitted monitoring report is not fulfilling the minimum requirement.				
Project participant response				Date: 21/01/2019
The description in section 1.9 of the MR has been revised to fulfil the requirement.				
Documentation provided by project participant				
The revised monitoring report date 31/01/2019 version 03				
DOE assessment				Date: 01/02/2019
Correction has been done in the revised MR /02/ and found OK. Hence this CAR is closed.				

CAR ID	03	Section no.	-	Date: 27/11/2018
Description of CAR				
Under section 3.2 of the submitted monitoring report:				
1. The monitoring equipment detail of the monitoring parameter "EC_{HPP_O,y}" is not consistent with the previous monitoring report i.e. for the monitoring period 04-October-2011 to 31-March-2014. 2. Serial no. for the monitoring equipment corresponding to the monitoring parameters "PO_y and EC_{HPP_O,y}" is mentioned as "NA". 3. The mentioned calibration date/validity for the monitoring equipment corresponding to the monitoring parameter Sol_y is not consistent with previous monitoring report i.e. for the monitoring period 04-October-2011 to 31-March-2014. 4. The Calibration details for the monitoring equipment corresponding to the monitoring parameter "FC_{i,y}" is missing.				
Project participant response				Date: 21/01/2019
1. The monitoring equipment detail of the parameter of EC_{HPP_O,y}, has been provided in section 3.2 of the revised monitoring report in line with the previous monitoring period. 2. The serial numbers of the monitoring equipment corresponding to the monitoring parameters PO_y and EC_{HPP_O,y} have been provided in section 3.2 of the revised monitoring report. 3. As per the submitted calibration report, the calibration date for the monitoring equipment corresponding to the monitoring parameter Sol_y is 05/08/2010 (5th August 2010) and the validity is 04/08/2010 (4th August 2010). However, there was incorrect format of the date presented in the emission reduction calculation sheet of the previous monitoring period. 4. The details of calibration and monitoring equipment corresponding to the monitoring parameter FC_{i,y} have been provided in section 3.2 of the revised monitoring report.				
Documentation provided by project participant				
1. The revised monitoring report date 31/01/2019 version 03 2. Calibration report of EC_{HPP_O,y} date 14/05/2010, 07/10/2016, 09/10/2017 and 13/07/2018 3. Calibration report of Sol_y date 05/08/2010 and 08/12/2018 4. Calibration report of FC_{i,y} date 20/07/2017 and 19/07/2018				
DOE assessment				Date: 01/02/2019
1. The monitoring equipment details have been updated in the revised MR /02/ and found ok. Hence this part of CAR is closed. 2. The monitoring equipment details have been updated in the revised MR /02/ and found ok. Hence this part of CAR is closed. 3. The calibration details are updated in the revised MR /02/ and found consistent with the Calibration records /13/. Hence this part of CAR is closed. 4. The calibration details are updated in the revised MR /02/ and found consistent with the Calibration records /13/. Hence this part of CAR is closed.				

Table 4. FAR from this verification

No FAR from this verification

FAR ID	XX	Section No.	-	Date: DD/MM/YYYY
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Description of FAR	
Project participant response	Date: DD/MM/YYYY
Documentation provided by project participant	
DOE assessment	Date: DD/MM/YYYY